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Instructional Television Transmission System for the Genesee Valley Area.

Brown Associates, Rochester, N.Y.

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In the entire Genessee Valley area of New York, only two channels are available to educators. Therefore, a study was made of the feasibility of constructing a multi-channel system for the transmission of television and data signals to schools in the area. Field strength measurements were taken of the local educational broadcast signal WXXI-TV to determine extent of coverage. Various problems of terrain and reception were identified, and various approaches to their solution were designed. Factors taken into account were BOCES communication centers, costs and financing, location of the Rochester control center, and FCC regulations. In each of the four systems considered, a microwave system arranged "round-robin" fashion was provided to overcome some of the deficiencies of the "off-air" Instructional Television Fixed Service (ITFS) repeating technique. The study ended with the conclusion that a few strategically located translators could provide significant improvement in the WXXI-TV coverage not now adequately serviced by CATV systems. It was further concluded that all schools using WXXI-TV be equipped with crystal controlled convertors and distribution systems to provide high quality signals in every classroom. These systems must be designed and installed with future ITFS utilization in mind in order to provide future system compatibility. (MF)

EDO 24265

MAY 1968

INSTRUCTIONAL TELEVISION TRANSMISSION SYSTEM

FOR

THE GENESEE VALLEY AREA

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PREPARED FOR

THE ROCHESTER AREA EDUCATIONAL TELEVISION ASSOCIATION

ROCHESTER, NEW YORK

BROWNE ASSOCIATES

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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SECTION I

SYSTEMS BACKGROUND INFORMATION

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TABLE OF CONTENTS

PART I

Section	Title	Page No.
I	Systems Background Information	1-6
II	Systems Applications	7-23
III	Estimated System Construction Costs	24-35
IV	Conclusions--Recommendations	36-41
V	Illustrations	42-58

Part II of this Report is bound separately and contains all supporting technical data.

BACKGROUND INFORMATION

EDUCATIONAL COMMUNICATIONS SYSTEMS

Prior to discussing the specific applications of electronic hardware to the communications needs of the schools in the Genesee Valley area, it would be valuable to briefly review some of the types of systems available to educational users. The discussion will be limited to owned systems, as contrasted with leased systems, although in many cases leased systems are available to perform the same types of services.

BROADCAST - The most visible and familiar type of communication system is the broadcast station. By definition, these stations transmit with facilities adequate to reach the general public via the home receiver. Broadcast frequencies are available to qualified educational applicants in both the television and radio services. A portion of the FM band (88.0 - 92.0 mHz) is reserved for educational use and television broadcast channels are reserved in most major cities for ETV use.

In Rochester, WXXI operates on Channel 21, the reserved educational channel. Channel 61 might be available for ETV use, but is not reserved for that purpose. One other city in the general area has a reserved ETV channel, viz; Corning, New York - Channel 30, which has yet not been activated.

Several educational FM stations operate in the area including WGSU at Genesee and WIRO at Rochester. Because of height, terrain and power limitations, neither of these stations cover a significant portion of the area.

The broadcast stations must be operated within transmission limitations well defined by the FCC, and, therefore, may not be effective as total communications tools. The broadcast television channel, for example, may only be used for the transmission of standard (EIA - FCC) television signals while the FM stations may be used only <u>incidentally</u> for purposes other than aural programming to the general public by the use of sub-channels riding "piggy back" on the main channel programming.

Aside from the limitation to standard television transmission, the other most notable deficiency in the use of the TV broadcast service is the lack of sufficient

channels to adequately serve the needs of the educational user. Educators have consistently demonstrated the need for multiple channels, but, as noted earlier, only two channels are available in the entire Genesee Valley area.

The possibility of obtaining additional broadcast channels for ETV use is not very good because of a highly saturated allocations table in the northeastern part of the United States. However, additional channels for low power use may be available in the high end of the UHF band 70-83 which is now used primarily for translator services.

Translators are low power stations used to provide coverage in areas where direct service from a broadcast station is not possible, because of distance and/or terrain problems. The translator merely repeats the signal of the originating station without significantly altering any of its characteristics except frequency. Translators could be used, for example, to extend the coverage of WXXI, particularly in the southern extremes of its theoretical Grade B area.

ITFS SYSTEMS. The Instructional Television Fixed Service Rules make available a potential 31 channels for educational use in the 2500 - 2690 mHz portion of the spectrum. These channels are arranged into seven groups of four (A-G) and one group (H)

of three, and normally, the individual applicant is permitted the use of only one group. This service employs special transmission and reception equipment and is not intended for program distribution to the general public. The significant feature about the ITFS systems are their inherent multi-channel capability. However, they do require expensive receiving installations in comparison to those required for reception of broadcast stations, but, generally speaking, they are less expensive to operate from the transmission standpoint.

Present FCC regulations do not preclude the use of ITFS channels for non-television purposes on an incidental basis. Thus, it may be possible to use ITFS channels on a part-time basis for data transmission, slow scan television, multiple channel audio, facsimile, or any other signal which can be impressed upon the carrier within the bandwidth limitations of the assigned channels. The current problem with these alternate uses is the availability of suitable terminal equipment to effectively and economically process the signals, but there is no reason to believe it would not be made available if the need was demonstrated by educational users.

The ITFS system normally employs the same signal format as standard television broadcast stations and, therefore, the receiving equipment (convertor) output is a standard VHF signal

(or signals) which can be displayed on standard television receivers without special processing. The systems may use omnidirectional radiation, similar to broadcast stations, but are limited to very low power transmitters.

Only one system is presently in operation in the area. The Rochester Public Schools operate a three channel system in Group D which serves all schools in the city of Rochester. It is understood that they are contemplating expansion to a full four-channel system.

POINT-TO-POINT MICROWAVE. Channels are available in the Business Radio band for point-to-point microwave systems. This service can provide a high quality "backbone" for any educational communications system since the inherent broadband characteristics and FCC regulations will permit the transmission of signals in almost any form. The system will find application for interconnecting centers and key locations used for control and distribution of signals to individual schools. The microwave system has the advantage of being able to transmit simultaneously various signals of differing format such as a television signal, several data channels and an audio channel. The technical advantages of

such systems are discussed in further detail in the latter part of this report.

OTHER SYSTEMS. Other systems available to educational users would include cable systems either leased or owned. CATV companies can provide spectrum for ETV use (other than carrying off-air broadcast signals) provided that they are not prevented from doing so by tariff or franchise limitations.

A petition for rule making is now before the FCC which would assign the frequencies between 2686-2690 mHz for educational use in conjunction with ITFS systems. The proposal is to use the frequencies for talk-back purposes from school locations and it is conceivable that, if approved, they could be used for other purposes such as data transmission.

Slow scan television, Xerography (LDX) and other narrow-band signals can be carried on leased lines or data phones available from local telephone companies. While this study is concerned primarily with the feasibility of establishing an owned distribution system, a discussion of the possible interface of leased and owned facilities for non-television applications is included.

SECTION II

SYSTEMS APPLICATIONS

SYSTEMS APPLICATIONS

The purpose of this study was to investigate the feasibility of constructing a practical multi-channel system for the transmission of television and data signals to the Genesee Valley area. This section of the report will discuss the application of the systems discussed earlier to this basic goal.

The extension or improvement of WXXI coverage will be discussed briefly. The recommendations are based on topographic data amassed for the primary purpose of establishing an ITFS system in conjunction with field strength data supplied by the station. This discussion is treated as a separate matter and not as a part of the overall recommendations relating to the ITFS system.

An ITFS system can take several forms, as will be shown, and the selection of the eventual system configuration will be based on economic and utilization factors within the limitations established by technical criteria.

The application of a microwave system for television and data transmission complementing and supplementing the ITFS system is also discussed as valuable adjunct to the overall composite system.

In the following discussions many of the technical details have been omitted for the sake of clarity. Detailed technical data is contained in Part II of this report and reference to that part will indicate the supporting information on which conclusions and recommendations found in this section are based.

The financial data included in this section is qualified as to items not included. Caution must be exercised in applying costs shown herein to other system configurations as such systems may be significantly different, and the resulting cost estimates may be invalid.

WXXI COVERAGE

Field strength measurements were taken by the Chief Engineer of WXXI during March and April, 1968 to determine the extent of coverage of WXXI in all areas covered by this study except Allegany County.

Allegany and Steuben Counties have extremely rugged terrain and it is impossible to provide service to these areas except by using hill top receiving locations for each town and cabling or relaying the signals to the towns which typically lie in a valley.

WXXI coverage problems are also evident in parts of all remaining counties, except Monroe. Measurements indicate that sufficient signal is available in most hill top locations but very little or none is available in the valleys. An exception to this general rule was noted in the valley areas southwest of Rochester in northern Livingston County.

The profile graphs plotted primarily for the ITFS system are equally useful for prediction of WXXI coverage.

Reference to the profiles for Allegany and Steuben indicate the general problem in those areas as do the profiles for locations in all other counties where poor reception is being experienced.

The northwestern part of Orleans County experiences poor reception because of rising terrain west of Brockport. This problem could be eliminated by the use of a translator at Medina. From Medina all locations except Holley could be covered with theoretical 1000 micro volt signals or better--which would be an improvement over the signals recently measured in that area. Medina was selected only because of its function as a BOCES center. A more suitable location would be more centrally situated in the county, perhaps near Albion.

Eastern Wayne County experiences similar terrain difficulties and reception problems.

Unlike Orleans County, however, Wayne County does not appear to have a single location at which a UHF translator could be used effectively to cover the area. The terrain is the principal problem. Thus, several translators would be required to adequately serve this area.

Waterloo and Seneca Falls do not receive any signal from WXXI because of the terrain to the west. These

locations could be served by a translator in Clifton Springs (with weak signals) as indicated by the profiles. However, a translator located on high terrain northwest of Geneva could serve Geneva, Waterloo and Seneca Falls.

Most locations in Genesee County, except areas west of Batavia, receive usable signals. The test data indicates very poor signals in Corfu, but the path profiles would tend to indicate that signal should be available with a receiving antenna height of 70-100 feet. Thus, a low power UHF translator could be located in Corfu to cover that town or, if general public reception is not desired, a tower at the school should provide adequate signal.

Wyoming County's rugged terrain poses problems at locations such as Wyoming, Arcade and others. It appears to be impractical to serve these areas with translators.

The same pattern holds true for southern Livingston County, southern Ontario County, and Yates County.

In reviewing the above situations it appears that the best approach to assure WXXI coverage in these areas is to persuade the CATV operators in locations beyond the WXXI theoretical Grade B coverage to carry Channel 21 on their

systems. A few locations in which translators might be practical are Geneva-Waterloo-Seneca Falls, Nunda-Dalton, Warsaw-Perry, Naples-Rushville, Medina-Albion, and Pen Yan-Branchport.

A possible configuration of a translator system is shown in Figure 1.

The translators would operate either on VHF channels or the upper 14 (70-83) UHF channels. If it is deemed desirable to use translators to cover individual towns, low power (1 watt) VHF units could be used. For coverage of large areas, such as Medina-Albion, 100 watt UHF translators will be required.

BASIC ITFS SYSTEM

The desired configuration for a multi-channel distribution system is shown in Figure 2. The functional concept of this system is as follows:

1. ITFS transmitters will be located at each BOCES center.

2. The BOCES centers will have the capability to originate programs and control distribution to all schools in the county.

3. Spencerport and Fairport will serve as primary distribution centers to other BOCES centers.

4. Programs will be transmitted from a central location in Rochester to the BOCES via Fairport and Spencerport.

However, analysis of paths and terrain indicates that it is impractical to consider coverage of Allegany, Steuben and Yates counties from their respectiv BOCES centers because of severe terrain problems.

The first system development which could serve part of the area is shown in Figure 3 as System A. In this system the BOCES centers in each county except Allegany, Steuben and Yates are retained as transmission centers (Wyoming and Seneca County locations are served

from BOCES centers in other counties.) This approach to the design of a system will meet the requirements originally outlined except as follows:

1. High towers will be required at many receiving locations--up to 250 feet at some locations.

2. Locations which will require tower heights over 250 feet were considered to be unserviceable and include:

   Warsaw
   Wyoming
   Dansville
   Wayland
   Nunda
   Honeoye
   Naples

   All locations in Steuben, Allegany and Yates Counties.

A refinement of System A is shown in Figure 4 which is referred to as System B. The major changes from A to B are:

1. The addition of a repeater on Sand Hill in northern Steuben County which in turn serves low power repeaters in several locations, in addition to direct service to locations in Livingston County.

2. Moving the Williamson transmission center to Walworth to serve the northern part of Wayne County.

3. Serving all locations in southern Wayne County from Clifton Springs.

4. Serving Kendall and Holley (Orleans County) from Spencerport.

System C is shown in Figure 5 and depicts the overall configuration with the elimination of the Wayne and Orleans

County transmitters.

System D is shown in Figure 6 and depicts the overall configuration when the Fairport and Spencerport transmission points are replaced by a single origination point in Rochester. Figure 6A depicts a portion of a system investigated for the purpose of providing coverage in western Wyoming County. As the profile graphs in Part II of this report indicate, this approach is not practical because of severe terrain problems.

In each of the above system developments, except A, the approach was to reduce the complexity and the cost of the system by maximizing the coverage of each ITFS transmitter without necessarily retaining the BOCES center as an origination and transmission point. However, origination capability could be achieved at the BOCES centers by the use of low power 2500 mHz links relaying signals from the centers to the ITFS transmitters or through microwave or cable interconnections.

System D can be supplemented by low power active repeaters or "beam benders" which can serve valley areas by relaying signals over short distances from a nearby hill top thus providing service to almost all locations except those in southern Allegany and Steuben Counties.

OTHER ITFS SYSTEM DESIGN FACTORS

In progressing towards the development of a practical ITFS system and associated interconnections, it is necessary that the designer have a clear guide as to the function of the system in terms of achieving a specific goal or set of goals. Unfortunately, in the design of this system, the capabilities of the system were not too clearly defined primarily because of uncertainty regarding the type of system that would be feasible.

The role of the BOCES center in this system is not too clearly defined. Is it, for example, <u>desirable</u> or <u>essential</u> that the BOCES have local control and origination capability?

If it is <u>essential</u>, then only a system taking the configuration similar to System A is acceptable.

If it is only <u>desirable</u>, then the centers need be retained (geographically) as transmission points only if the system economics do not weigh heavily against such a configuration.

From a practical standpoint it has been determined by actual inspection that the existing BOCES centers are in most cases physically unsuitable for tall tower installations. In Batavia, for example, the tower would have to be mounted on top of an existing building which may not be feasible. In addition, FAA restrictions further compound the Batavia tower situation. Livonia was selected as a transmission point because of its central location but it is not a BOCES center. The present center, Leicester, is unsuitable because of terrain problems. Thus, it may be necessary to provide additional local interconnections between BOCES centers and actual transmitter locations, in order to meet all requirements.

However, it would seem that the only function presently at the BOCES centers that would require any electronic interrelationship with the proposed system would be the data processing equipment. Therefore, selection of sites other than the present BOCES centers probably should be given further consideration as the terminals for the communications system with leased wire lines between the centers and the transmission points for data processing needs.

In addition to economics, it will be necessary to consider factors such as FCC regulatory aspects (particularly

regarding the number of channels available), FAA requirements in terms of tower heights, and system performance criteria in terms of establishing a minimum level of operational quality.

Transmission capabilities must also be carefully defined in terms of non-television applications. If "data" is to be transmitted, it will be necessary to define the required input and output terminal equipment.

The location of the control center in Rochester is unknown at this time. For design purposes it was assumed that Pinnacle Hill would be used as a transmission point, or a tower of a height equivalent to that of the structures on Pinnacle Hill would be available. The new Xerox building, for example, would make an ideal location for the transmission center. Assuming that the transmission equipment and the distribution center are separated, such as the case would be if Pinnacle Hill and a location in downtown Rochester were used respectively, it will be necessary to provide additional equipment to link the center and transmission point, increasing cost and complexity.

Other factors which must be considered in the system design will include the FCC rules and regulations regarding the number of channels available to a single applicant

(the present rules provide for a maximum of one group of channels to a single organization or, in other words, a maximum of four channels) and the effect of the existing ITFS system operated by the Rochester Public Schools.

The technical aspects of channel selection factors are included in a later part of this report. The result of a channel allocation study indicates that five groups would be required for systems "A"-"C" while system "D" would require only three groups of channels.

It is very likely that the FCC would approve the latter situation (three groups) and unlikely that the former would receive approval. Systems "A"-"C" would effectively use all available channels since interference problems and the existing ITFS system would render the remaining groups almost useless in the Rochester area. System D would leave at least two groups for use by other organizations.

The role of the Rochester Public Schools' ITFS system has not been defined and it has been ignored in this study for all practical purposes. It should be recognized, however, that this system could serve as the nucleus for an ITFS system provided that changes were made in the transmitter location and/or tower height to conform with the recommendations in the technical section of this report.

MICROWAVE INTERCONNECTIONS

In each of the system configurations discussed above, a "microwave back-bone" has been provided to overcome some of the deficiencies of the "off-air" ITFS repeating technique. The microwave system is arranged in a "round-robin" fashion, i.e., signals from the central control point are transmitted to one BOCES center and then to the next, and so forth, and signals from the last BOCES are sent back to the main control center, as shown in Figures 7-10 whenever this approach is practical.

The round-robin approach is the least expensive method of achieving a two-way system. However, this economy is achieved at the sacrifice of the total flexibility offered in a two-way system in which each center would have a two-way link directly to and from the main control center. In each system (A-D) design it is assumed that the BOCES and ITFS transmission points are common locations.

As a practical matter this may not be the case. From a systems design standpoint, it is normally undesirable to have any single microwave path over twenty-five miles in

length and the total number of hops in the system should be kept to a minimum. Thus, all systems depicted have some drawbacks using these criteria. Also note that it is impractical to link the Livonia and Clifton Springs Centers because of terrain problems.

It should be noted the basic microwave trunking system can be expanded to multi-channel capability by adding hardware once the initial system, as outlined herein, has been constructed.

Figure 11 shows a system configuration in which it is assumed that:

1. System "D" is an ideal approach from an ITFS distribution standpoint.

2. All ITFS transmitters (Rochester-Batavia-Livonia-Clifton Springs) are in locations other than the BOCES centers (which are the desired microwave terminals).

The system shown in Figure 11 will be referred to as the Alternate Microwave System in further discussion in this report.

All BOCES may have two-way microwave interconnections in this configuration and the microwave can be added when required to handle data and non-ITFS television distribution/transmission tasks.

Figure 12 shows a variation of this microwave system which provides full-time two-way transmission to all BOCES from Rochester. The problem with this system, aside from cost, is the fact that seven two-way channels (14 total) would be required at Rochester if the center and transmission point were not co-located.

For the purposes of preliminary discussion of data transmission needs it will be assumed that the common terminal instrument will be the standard teletype set. It is probable that the desired system will take the form of leased lines and data sets interconnecting each BOCES center with its respective schools.

At the BOCES center terminal and switching equipment will be required to get any particular school terminal "on-line" to connect it with the central computer/data processing center in Rochester via the microwave system. As mentioned earlier, with proper terminal equipment it would be possible to have such data interconnections with simultaneous audio-vidio transmission on the microwave system.

A major problem may exist in terms of telephone company policy and tariff restrictions regarding the interface of their equipment with privately owned systems. Most

companies are reluctant to make such interconnections except under carefully controlled conditions.

It will be necessary, therefore, to define the data requirements in terms of local needs--between BOCES centers and individual schools--and between BOCES centers and some other centralized computer data processing center in Rochester.

The former application, as previously indicated, will be best handled by the use of leased facilities while the latter may be best handled as a part of the owned micro-wave system. Interfacing or inter-connecting the two systems, should, therefore, be a primary concern requiring further study.

SECTION III

ESTIMATED SYSTEM CONSTRUCTION COSTS

ESTIMATED SYSTEM CONSTRUCTION COSTS

The following is an analysis of the economic factors relating to construction of the various system configurations. It should be recognized that the costs shown are for a basic television transmission system and are all inclusive except as follows:

A. Rochester city schools are not included in the Monroe County figures, and non-public schools are not included in any area.

B. Site acquisition and preparation costs are not included.

C. Building costs are not included.

D. School distribution (cable) system costs are not included.

E. Classroom receivers are not included.

F. Costs for terminal and interfacing equipment for data transmission/handling are not included.

G. Input equipment such as cameras, studio equipment, videotape, etc. are not included.

H. It is assumed that the required towers can be erected at the BOCES centers.

I. Tower costs for Rochester based systems are not included since existing structures may be available.

The costs for all of these items are dependent on a large number of variables which were not considered as part of this study. Data is provided, however, for estimating the costs of D and E above. The receiving costs listed include tower, antenna, ITFS convertor and installation. Transmission costs include transmitters, towers, antennas, transmission line, minimal terminal equipment and installation for one channel. Costs for additional ITFS channels include minimum terminal equipment and transmitter costs.

The microwave system costs include transmitters-receivers, antennas-reflectors, waveguide and installation. The costs listed are based on the assumption that existing towers (constructed for the ITFS system) will be used. Cost estimates for a composite system employing the Alternate Microwave System are given in a later part of this section and tower costs are included.

SYSTEM "A"

Not including Bath, Branchport and Belmont Centers.

Receiving Costs

	Schools	Total Cost
Orleans Co.	(15)	28,515
Genesee Co.	(22)	42,080
Livingston Co.	(14)	26,480
Ontario Co.	(29)	57,395
Wayne Co.	(26)	64,830
Monroe Co.	(107)	173,875
	(213)	$393,175

BOCES Centers

Medina	36,500
Batavia	35,000
Livonia	40,000
Clifton Springs	40,000
Williamson	40,000
Fairport	37,000
Spencerport	40,000
Rochester C.C.	20,000 *
	$288,500

12 KMC Microwave System

Spencerport	14,000
Medina	14,000
Batavia	14,000
Livonia	14,000
Fairport	14,000
Clifton Springs	14,000
Williamson	14,000
Rochester	14,000
	$112,000

Total System Cost

Receiving Sites	(213)	393,175
BOCES centers	(8)	288,500
Microwave	(8)	112,000
		$793,675

* Does not include tower costs.

Additional Channels

$14,000 for transmitter and processing equipment per center/per channel.
8 centers @ $14,000 = $112,000 per additional channel.

	CHANNELS			
	1	2	3	4
Total Costs	$793,675	$905,675	$1,017,675	$1,129,675
Average per school	3,750	4,270	4,800	5,320

SYSTEM "B"

Basic changes from "A"

1. Add Sand Hill Group
2. Change Wayne County transmission point
3. Pick up part of Wayne County from Clifton Springs
4. Pick up part of Orleans County from Spencerport

Receiving Costs

	Schools	Total Cost
Orleans Co.	(15)	25,875
Genesee Co.	(22)	42,080
Livingston Co.	(14)	26,480
Ontario Co.	(29)	57,395
Wayne Co.	(26)	43,950
Monroe Co.	(107)	173,875
	(213)	$369,655
Sand Hill Rec. Group	(17)	59,500
	(230)	$429,155

Transmission Center Costs

Medina	36,500
Batavia	35,000
Livonia	40,000
Clifton Springs	40,000
Walworth	34,500
Fairport	37,000
Spencerport	40,000
Rochester C.C.	20,000 *
	$283,000
Sand Hill	37,500
	$320,500

* Does not include tower costs.

12 KMC Microwave System

Spencerport	14,000
Medina	14,000
Batavia	14,000
Livonia	14,000
Fairport	14,000
Clifton Springs	14,000
Walworth	14,000
Rochester	14,000
	$112,000

Total System Cost

Receiving	429,155
Transmitting	320,500
Microwave	112,000
Total	$861,655

Additional Channels

$14,000 per channel/per center $126,000

	CHANNELS			
	1	2	3	4
Total Cost	$861,655	$987,655	$1,113,655	$1,239,655
Per School	3,750	4,270	4,800	5,320

SYSTEM "C"

Basic changes from "B"
Elimination of Wayne and Orleans County Centers

Receiving Costs

	Schools	Total Cost
Orelans Co.	(15)	35,100
Genesee Co.	(22)	42,080
Livingston Co.	(14)	26,480
Ontario Co.	(29)	57,395
Wayne Co.	(26)	51,900
Monroe Co.	(107)	173,875
		$386,830
Sand Hill Rec Gp.	(17)	59,500
		$446,330

Transmission Center Costs

Batavia	36,500
Livonia	40,000
Clifton Springs	40,000
Fairport	37,000
Spencerport	40,000
Rochester C.C.	20,000 *
	$213,500
Sand Hill	37,500
	$251,000

12 KMC Microwave

Spencerport	14,000
Batavia	14,000
Livonia	14,000
Fairport (2)	28,000
Clifton Springs	14,000
Rochester	14,000
	$98,000

Total System Costs

Receiving	446,335
Transmitting	251,000
Microwave	98,000
Total	$795,335

*Does not include tower costs.

Additional channels

$14,000 per channel/per center $91,000

CHANNELS

	1	2	3	4
Total cost	$795,335	$886,335	$977,335	$1,068,335
Per school	3,450	3,850	4,250	4,650

SYSTEM "D"

Basic changes from "C"
Elimination of Spencerport and Fairport as control centers.

Receiving Costs

	Schools	Total Cost
Orleans Co.	(15)	35,100
Genesee Co.	(22)	42,080
Livingston Co.	(14)	26,480
Ontario Co.	(29)	57,395
Wayne Co.	(26)	51,900
Monroe Co.	(107)	173,875
		$386,830
Sand Hill Group	(17)	59,500
		$446,330

Transmission Center Costs

Batavia	36,500
Livonia	40,000
Clifton Springs	40,000
Rochester	20,000 *
	$136,500
Sand Hill	37,500
	$174,000

*Does not include tower costs.

12 KMC Microwave System

Batavia	14,000
Livonia	14,000
Clifton Springs	14,000
Rochester (2)	28,000
	$70,000

Total System Cost

Receiving	446,330
Transmitting	174,000
Microwave	70,000
Total	$690,330

Additional Channels

$14,000 per channel/per center $70,000

CHANNELS

	1	2	3	4
Total Cost	$690,330	$760,330	$830,330	$900,330
Per School	3,000	3,300	3,600	3,900

Thus, in the progressive simplification of the system, the cost per school for the basic transmission complex has been reduced from $3,750 to $3,000 for a single channel, and from $5,320 to $3,900 for four channels. In the latter case, the area-wide savings amount to $340,000 (four channels System "B" compared to System "D"). In making comparisons of the various systems, note that "A" does not include the area served by the Sand Hill Group. In the comparison above a four-channel "A" system, including the group of schools served by the Sand Hill repeater, will cost almost $5,600 per school compared to the $3,900 for the similar "D" System, or, stated in another way, a savings of 30% can be realized by using the "D" approach.

If it is desired to include the parochial schools in the system cost estimates the figures shown in the following table may be added to the total system costs.

PAROCHIAL SCHOOL RECEIVING COSTS

SYSTEM "A"

Orleans	(5)	$ 9,550
Genesee	(6)	10,300
Livingston	(3)	5,640
Ontario	(6)	13,120
Wayne	(3)	10,000
Monroe	(10)	16,250
	(33)	$64,860

SYSTEM "B"

Orleans	(5)	$ 8,100
Genesee	(6)	10,300
Livingston	(3)	5,640
Ontario	(6)	13,120
Wayne	(3)	5,120
Monroe	(10)	16,250
	(33)	$58,530

SYSTEM "C"

Orleans	(5)	$11,600
Genesee	(6)	10,300
Livingston	(3)	5,640
Ontario	(6)	13,120
Wayne	(3)	5,120
Monroe	(10)	16,250
	(33)	$62,030

SYSTEM "D"

Orleans	(5)	$11,600
Genesee	(6)	10,300
Livingston	(3)	5,640
Ontario	(6)	13,120
Wayne	(3)	5,120
Monroe	(10)	16,250
	(33)	$62,030

In System D, for example, 263 public and parochial schools could be served with a four channel system at a total cost of $962,000 or $3,650 per school. Note also that if the Rochester Public Schools were serviced by this system that the total cost per school would drop to $2600, assuming that their existing ITFS receiving equipment was employed.

Other Cost Factors

A. Translator System. A UHF translator system as depicted in Figure 1 can be constructed for approximately $12,000 per site not including site preparation or acquisition. Thus, the total cost of providing translators in the six areas indicated would be approximately $72.000 plus site costs.

B. School Distribution Systems- Receivers. As mentioned previously, the ITFS receiving system costs do not include the cost of intra-building cable systems and outlets. These costs may be estimated as follows:

Basic Head End System	$ 500
Add for second and third ch.	200 each
Add for fourth channel	400
Add, per classroom	70

For example, a distribution system in a school with 15 rooms using a four channel system would cost:

Head End	$ 500
Channel Amplifiers (400+400)	800
Classrooms (70 x 15)	1050
	$2350

Receivers and stands can be estimated at $190 each.

C. BOCES Center to Transmission Center. A local link may be required to interconnect the BOCES center and the transmission center in some locations. As mentioned previously, Batavia, for example, may require a remotely located transmission center. It will then be necessary to provide the necessary interconnections. If it is found that such separation is desirable or necessary an interconnection can be provided for video transmission to the ITFS transmitters by use of a low power 2500 mHz link from the BOCES to the ITFS transmission point. This will provide for local origination from each BOCES participating in the system. The cost figures shown below do not include towers since it is presumed that they are existing at each location for the backbone microwave system:

Channels	Cost
1	$15,000
2	16,000
3	18,000
4	21,000

D. Alternate Microwave System. The costs for two round-robin loops serving Spencerport-Medina-Batavia-Livonia and Fairport-Williamson-Clifton Springs are shown below. They include the cost of the relatively low towers required and

installation. The costs are for a one channel 8 mHz baseband system which can be used for television-audio-data-facsimile-control or combinations thereof, depending upon the input channelizing equipment employed. The costs do not include such input and terminal equipment. Costs are also shown for a local Rochester system which may be required. (Note that 4 channels are required.) A cost is listed for serving Leicester with a two-way link if this is desired.

Rochester-Spencerport	$13,000	
Spencerport-Medina	15,000	
Medina-Batavia	14,000	
Batavia-Livonia	14,000	
Livonia-Rochester	13,000	
		$69,000
Rochester-Fairport	$13,000	
Fairport-Williamson	15,000	
Williamson-Clifton Springs	15,000	
Clifton Springs-Rochester	13,000	
		$56,000
Local Rochester System (4 channels)		$48,000
Leicester-Livonia (2-way)		$24,000

E. ITFS "Beam Bender" Repeaters. These systems may be used to provide coverage in areas not capable of being directly serviced by an ITFS transmitter because of terrain. The costs shown are for a self-supporting tower, electronics, antennas, thermoelectric power system and installation (cost of site preparation is not included.)

Complete System	$ 6,600

F. Low-Power VHF Translators. One watt VHF translators may be employed in a capacity similar to the ITFS "beam-benders" for relaying WXXI into low valley areas. These units may be installed in areas without power by using the thermoelectric generator-battery system. The costs shown below are all inclusive except for site acquisition and preparation.

Complete System	$ 5,900

SECTION IV

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS

WXXI Coverage. It would appear that a few strategically located translators could provide significant improvement in the WXXI coverage in areas not now adequately serviced by CATV systems. The recommendation, therefore, would be to provide translators as required and as justified by the potential increase in viewing audience. The translator facilities should be viewed in terms of providing service to the general public. It is probable that WXXI service to the schools can be provided in outlying areas if towers are installed for ITFS reception, thus eliminating the need for translators as far as school reception is concerned.

It is strongly recommended that all schools using WXXI be equipped with crystal controlled convertors and distribution systems to provide high quality signals in every classroom. The present method of attempting direct-indoor reception in classrooms at most schools is totally unacceptable. These distribution systems must be designed and installed with future ITFS utilization in mind in order to provide system compatability.

ITFS and Microwave Systems

The earlier discussion of the relative merits of the various approaches to the configuration and ITFS system should take indicated that System D was the most efficient from economic and spectrum utilization standpoints. This system, however, did not meet the original design criteria of providing control and distribution capabilities from each BOCES center and locations in Yates, Wyoming and Seneca Counties were not serviced.

The problem of the BOCES centers is effectively solved by the Alternate Microwave System described in a previous section.

The problem of unserved locations may possibly be solved through the use of low-power repeaters at each location similar to the technique employed in northern Steuben County.

The recommended approach for the total communications system which most closely meet the original design objectives is a composite of the ITFS portion of system "D" and the Alternate Microwave System with the possible addition of active repeaters serving as beam-benders to provide coverage in certain locations not otherwise served. The

final system configuration is shown in Figure 13. Additionally, it may also be more practical to use an ITFS repeater in Orleans County because of the very high average tower heights required in the "D" configuration. A determination of the exact approach will have to be made after an evaluation of the practicality of erecting these tall receiving towers at school locations versus the cost and complexity of installing another repeater at Medina. The Medina repeater would use a relatively low tower receiving from Batavia and retransmitting to Orleans County (Holley would still be served from Rochester).

The proposed system could be constructed on a phase-by-phase basis provided that the total system concept is clearly defined at the outset. Such an approach is given below:

PHASE I

A. Select sites for ITFS transmission in the four transmission center locations (Rochester, Batavia, Livonia and Clifton Springs.

B. Complete system design and engineering and prepare specifications.

C. File necessary FCC-FAA applications.

D. Apply for local permits.

E. Construct ITFS system with the Rochester Center serving as only distribution point and outlying transmitters serving as unattended repeaters, i.e., no local origination from the BOCES.

F. Define needs for local production, data transmission and interconnections at BOCES.

PHASE II

A. Complete design on microwave system.

B. File necessary FCC applications.

C. Design terminal and data interfacing facilities.

D. Install microwave system and ITFS links from BOCES Centers.

PHASE III

Complete extension of system to "Sand Hill Group" and Yates, Wyoming and Seneca County locations not previously served. Add additional channels to basic system as required. Add data terminal equipment.

The revised cost estimates for each phase would be as follows (for a single channel system):

PHASE I	
Basic Transmission/Reception Systems	$523,330
Rochester Local ITFS Link	15,000
Total	$538,330
PHASE II	
Basic Microwave System	$125,000
ITFS Links from Centers	51,000
Rochester Local System (if required)	48,000
Leicester System (if required)	24,000
Total	$248,000

PHASE III

Costs variable depending upon functions desired. (See previous section on cost analysis for specific data)

* * * * * *

Obviously there are other combinations of system construction but it would appear that this is the most logical approach since it allows for a building block approach to the development of a comprehensive educational communications system.

It is suggested that several basic areas must be more clearly defined prior to proceeding with a final system design, including:

A. The role of the BOCES Center as a communications control center.

B. The nature and function of the central program/data center in Rochester.

C. The role, if any, of the existing ITFS system operated by the Rochester Public Schools.

D. The desired capabilities for video transmission.

E. The form and interconnection requirements for data transmission.

F. The feasibility of using leased cable facilities to serve some or all the transmission needs.

In conclusion, it is apparent that a practical ITFS system can be constructed to serve most of the schools in the

Genesee Valley area with a multi-channel instructional television service and that a complementary wideband microwave system can be superimposed and interfaced with the ITFS system to provide a viable system for data transmission, local television origination, and extraordinary television applications.

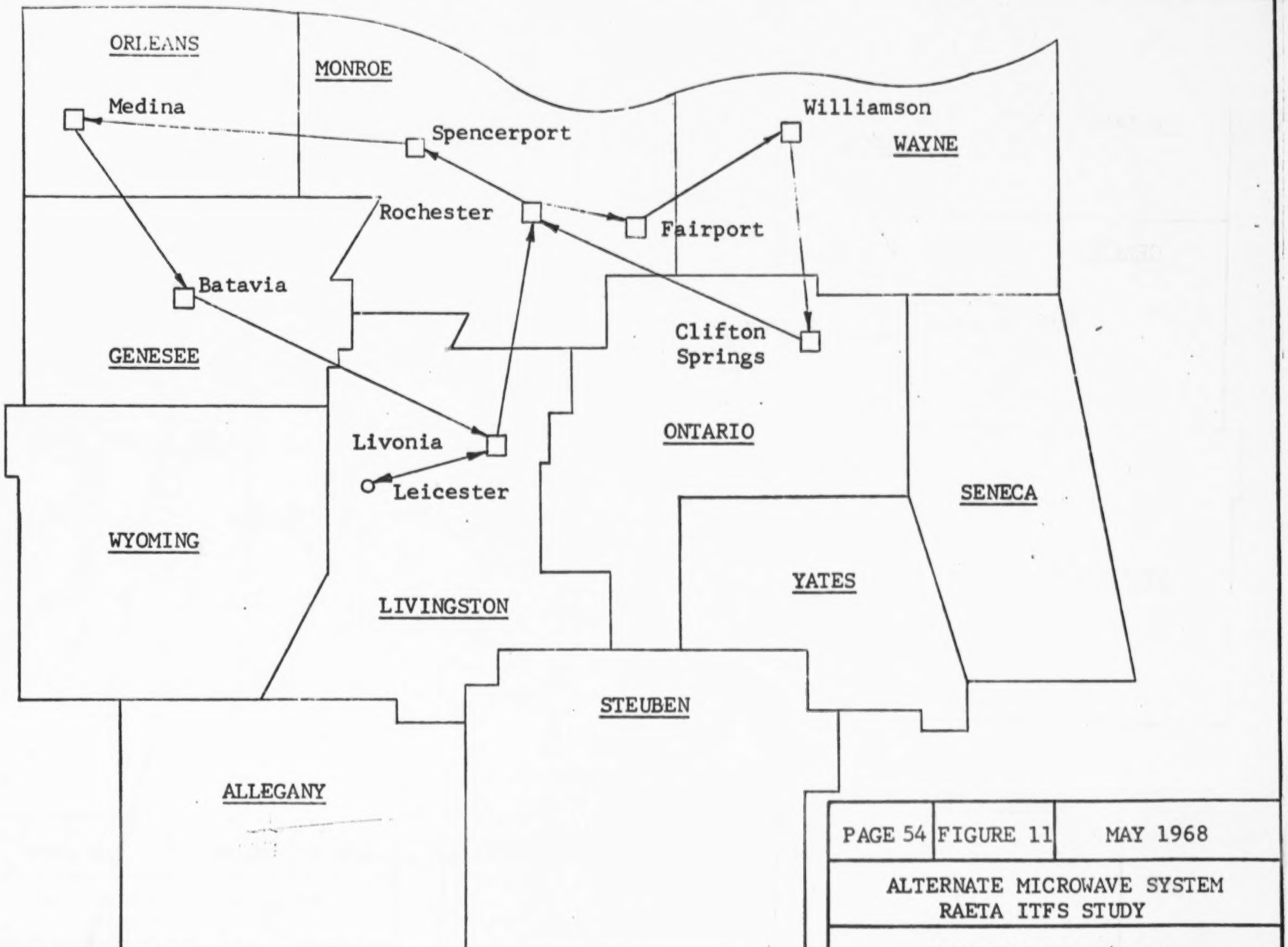
However, further study will be required from a utilization standpoint and the system design will have to be modified to meet the specific needs determined in the utilization study.

SECTION V

ILLUSTRATIONS

LIST OF ILLUSTRATIONS

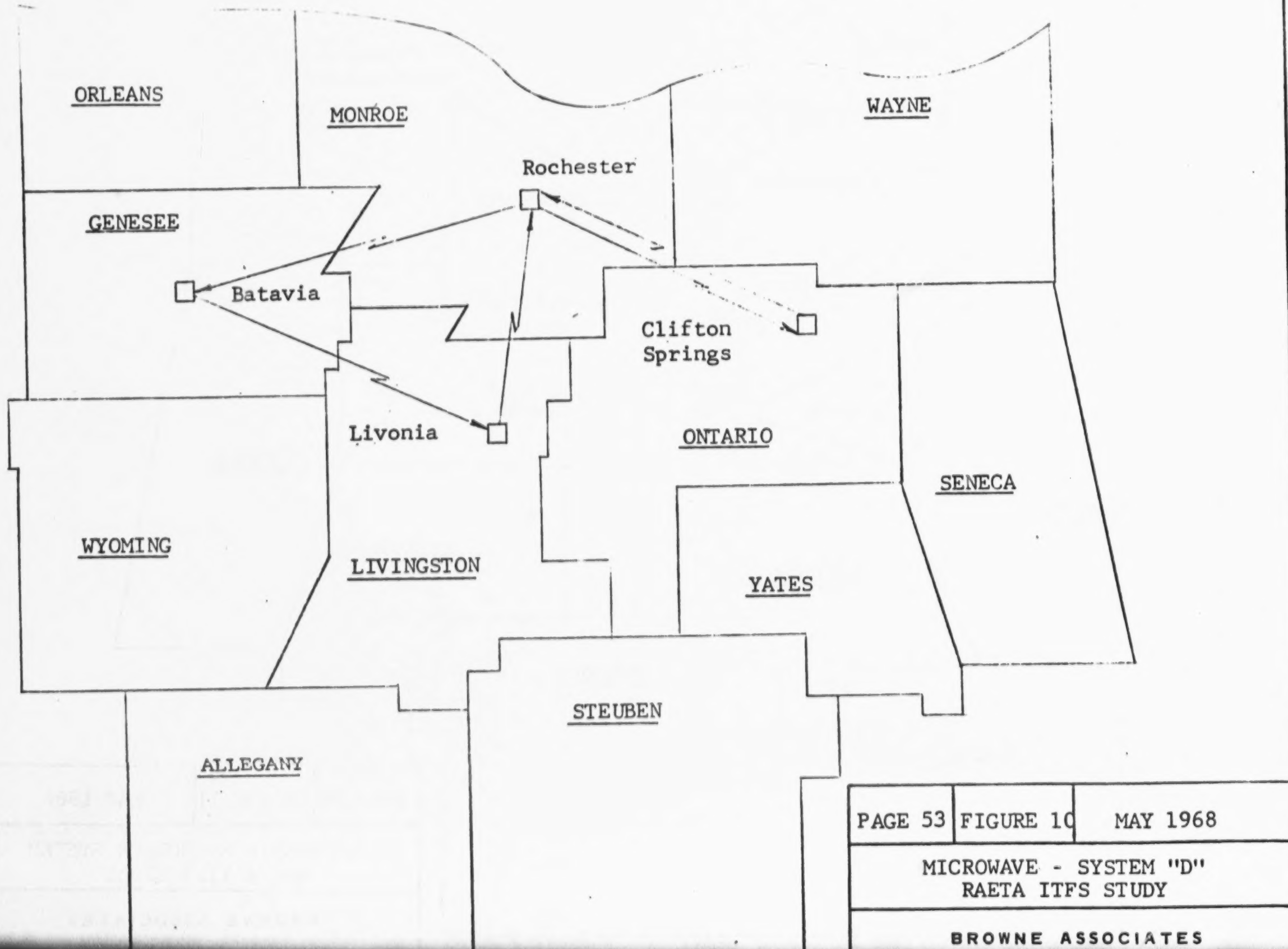
Figure	Title	Page
1	WXXI Translator System	43
2	Proposed ITFS System	44
3	ITFS System "A"	45
4	ITFS System "B"	46
5	ITFS System "C"	47
6	ITFS System "D"	48
6A	Orangeville Center Repeater	49
7	Microwave - System "A"	50
8	Microwave - System "B"	51
9	Microwave - System "C"	52
10	Microwave - System "D"	53
11	Alternate Microwave System	54
12	Two-Way Microwave System	55
13	Recommended System Configuration	56
14	Receiving Site Location Key	57
	KEY INDEX	58-59



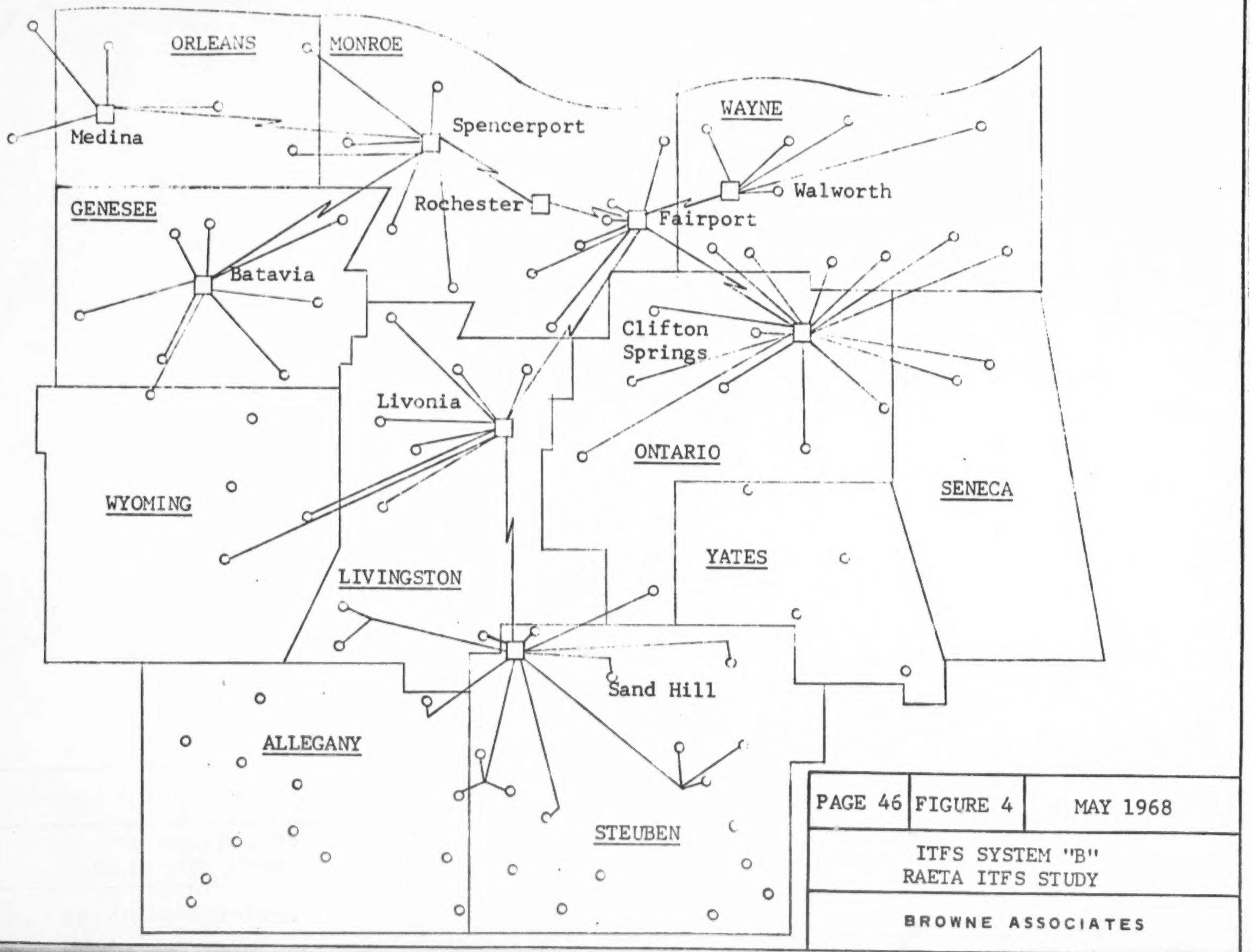
PAGE 54	FIGURE 11	MAY 1968

ALTERNATE MICROWAVE SYSTEM
RAETA ITFS STUDY

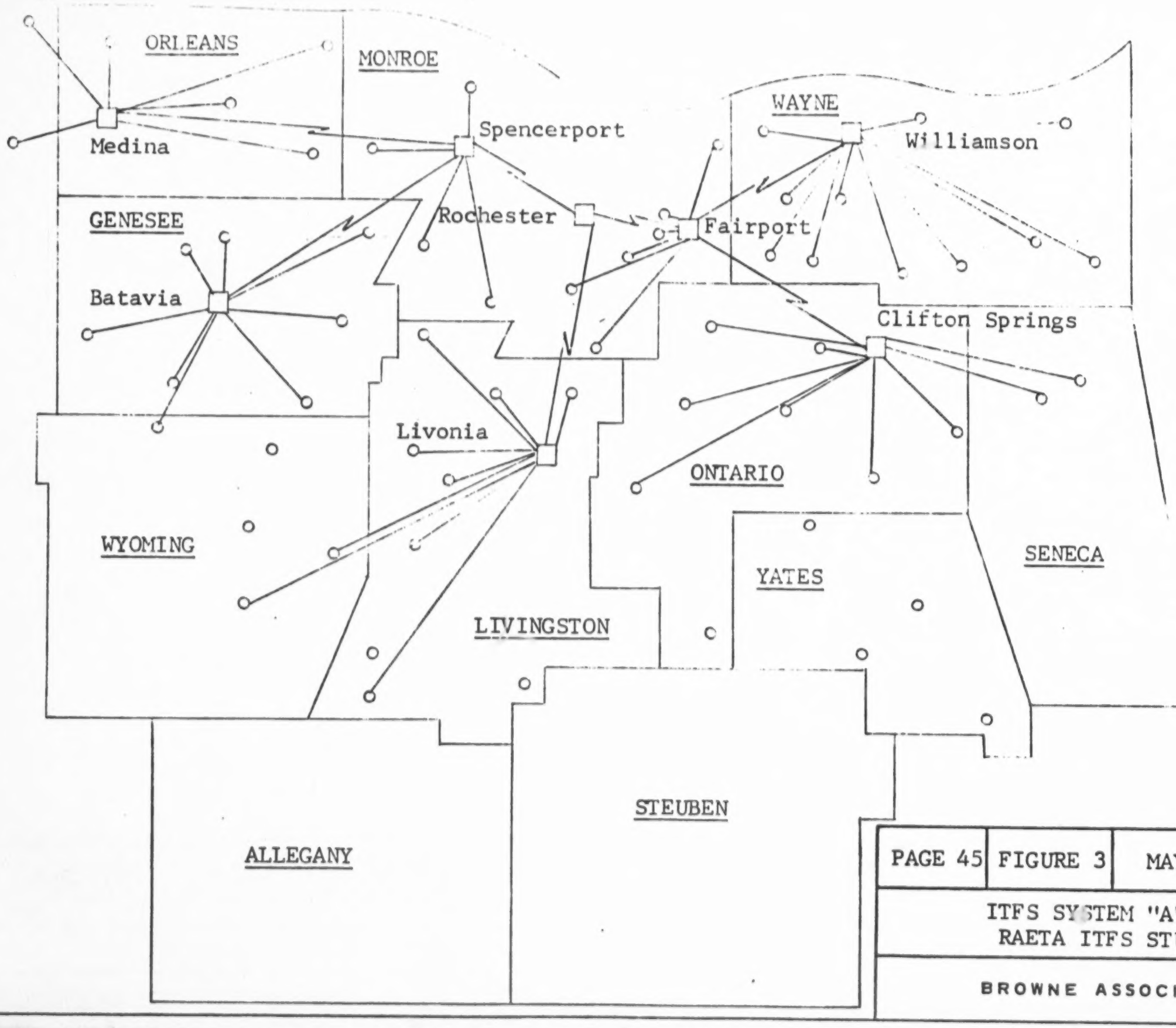
BROWNE ASSOCIATES



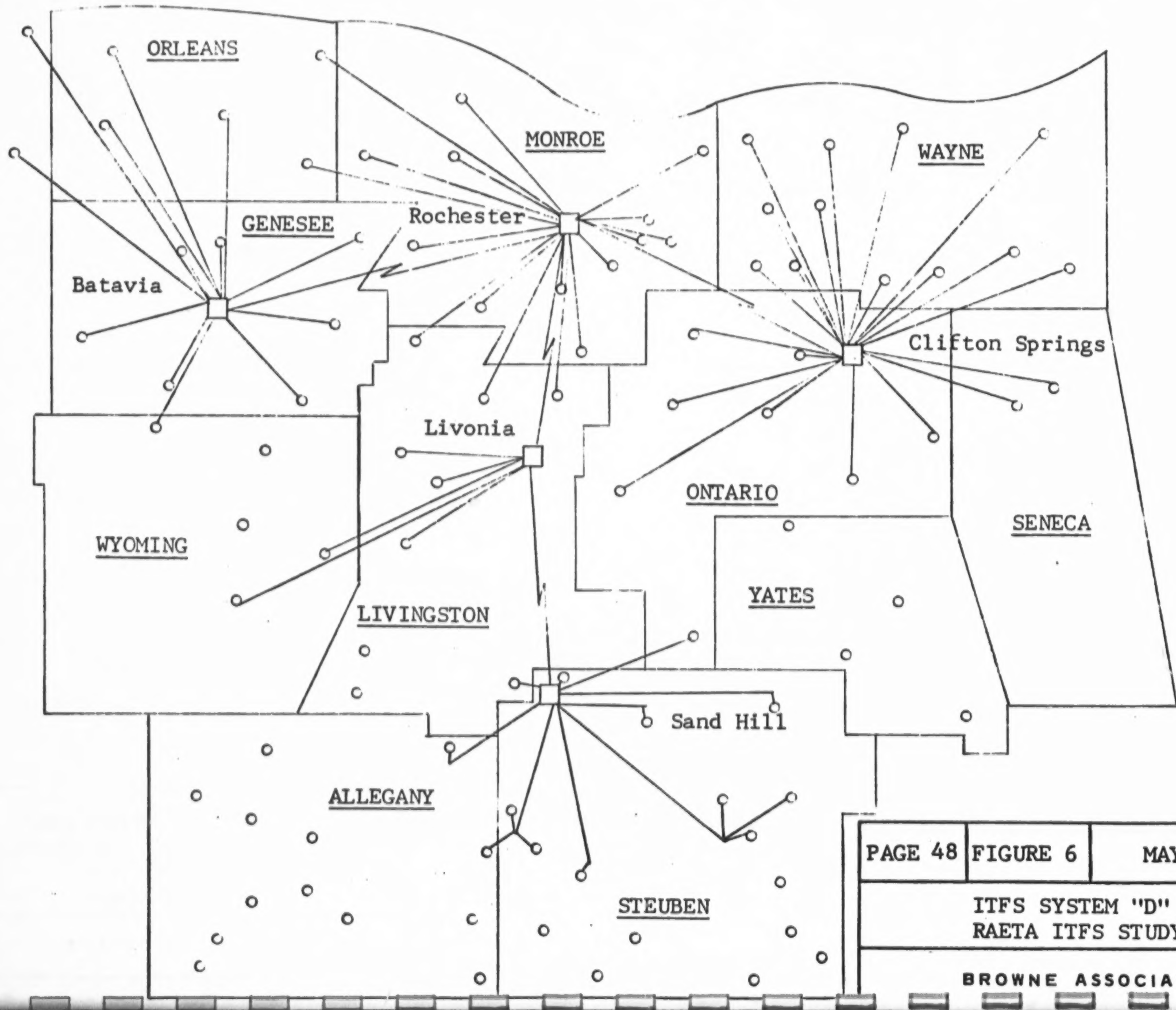
PAGE 53	FIGURE 10	MAY 1968
MICROWAVE - SYSTEM "D" RAETA ITFS STUDY		
BROWNE ASSOCIATES		



PAGE 46	FIGURE 4	MAY 1968
ITFS SYSTEM "B" RAETA ITFS STUDY		
BROWNE ASSOCIATES		



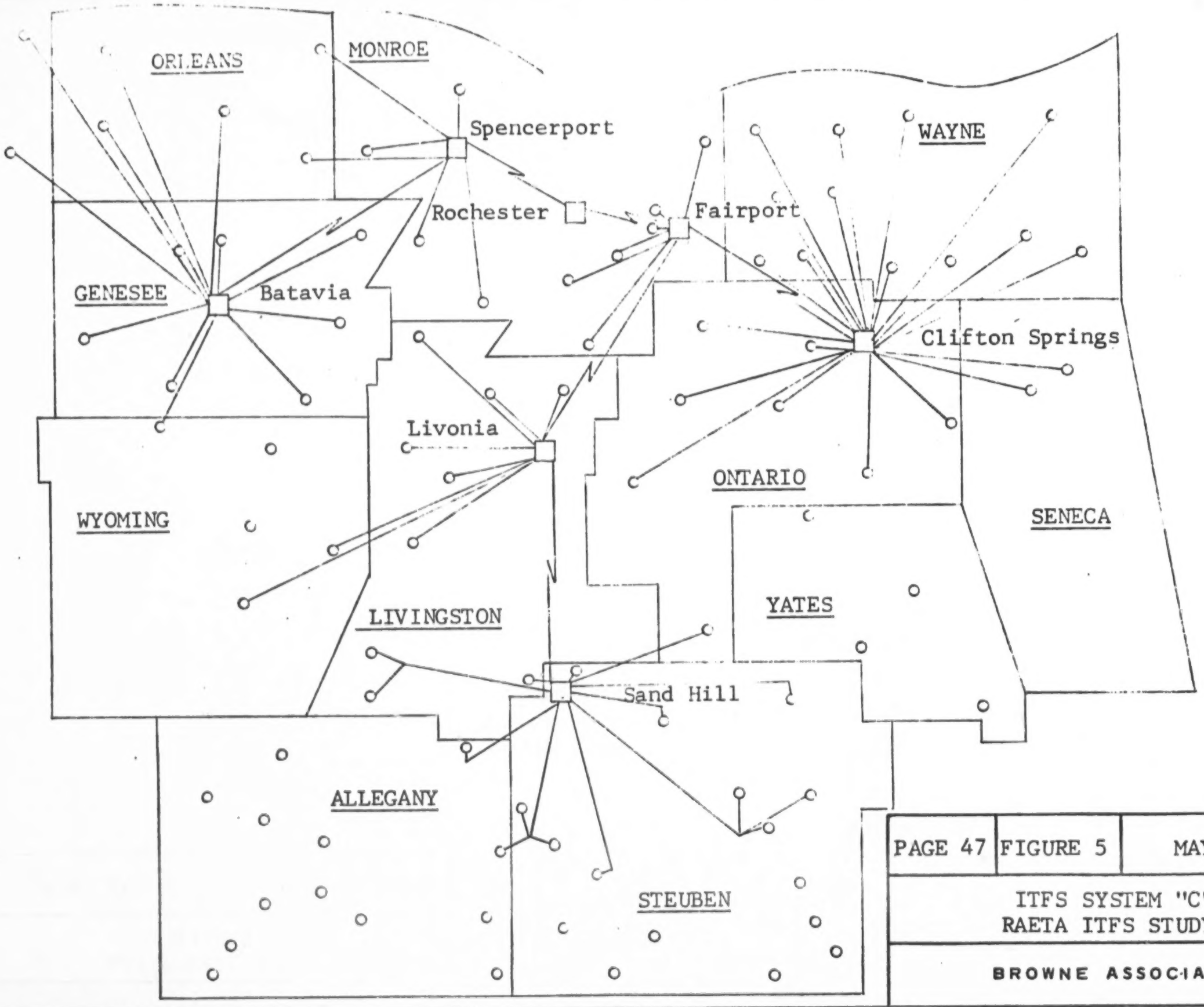
PAGE 45	FIGURE 3	MAY 1968
ITFS SYSTEM "A" RAETA ITFS STUDY		
BROWNE ASSOCIATES		



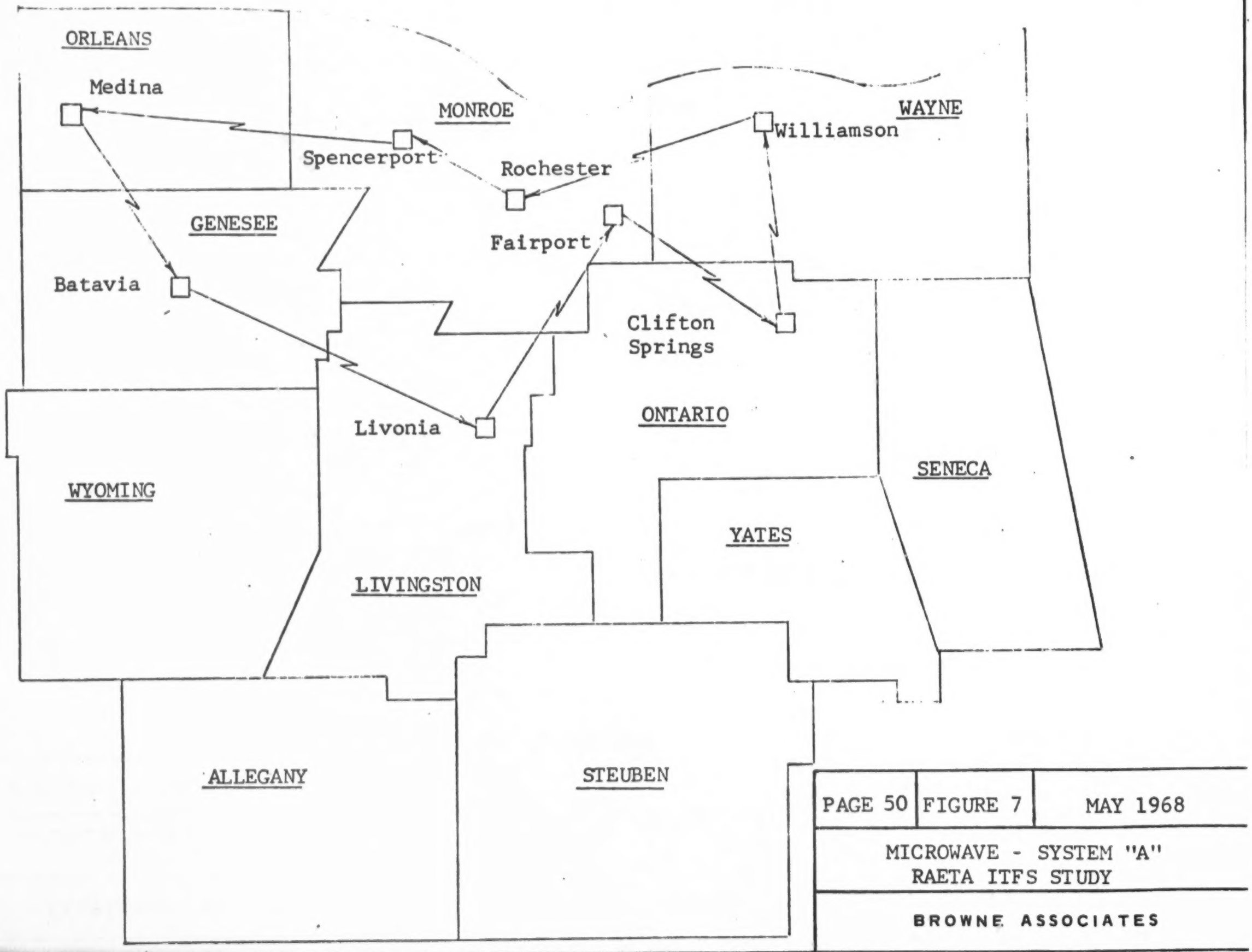
PAGE 48	FIGURE 6	MAY 1968

ITFS SYSTEM "D"
RAETA ITFS STUDY

BROWNE ASSOCIATES



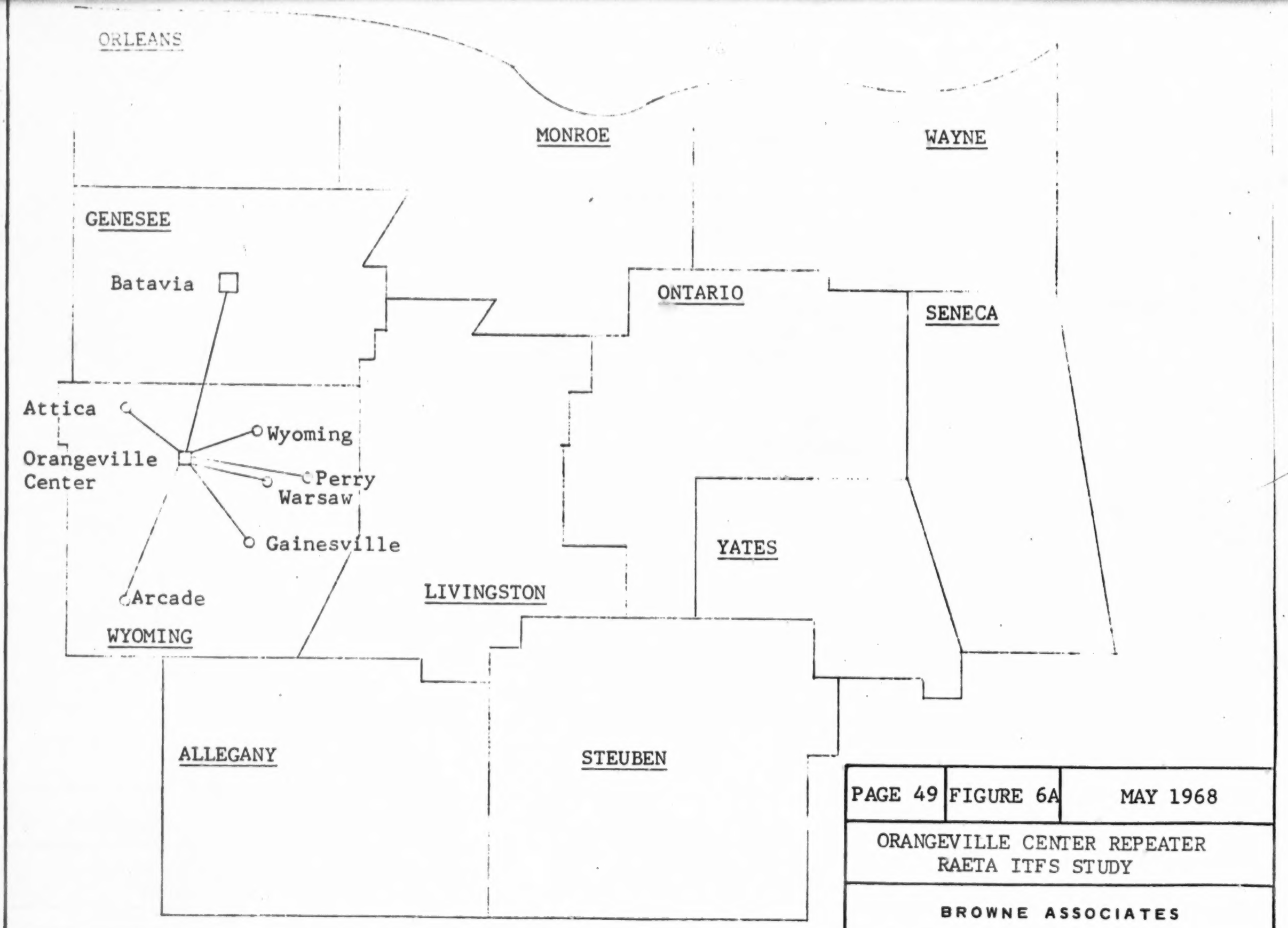
PAGE 47	FIGURE 5	MAY 1968
ITFS SYSTEM "C" RAETA ITFS STUDY		
BROWNE ASSOCIATES		



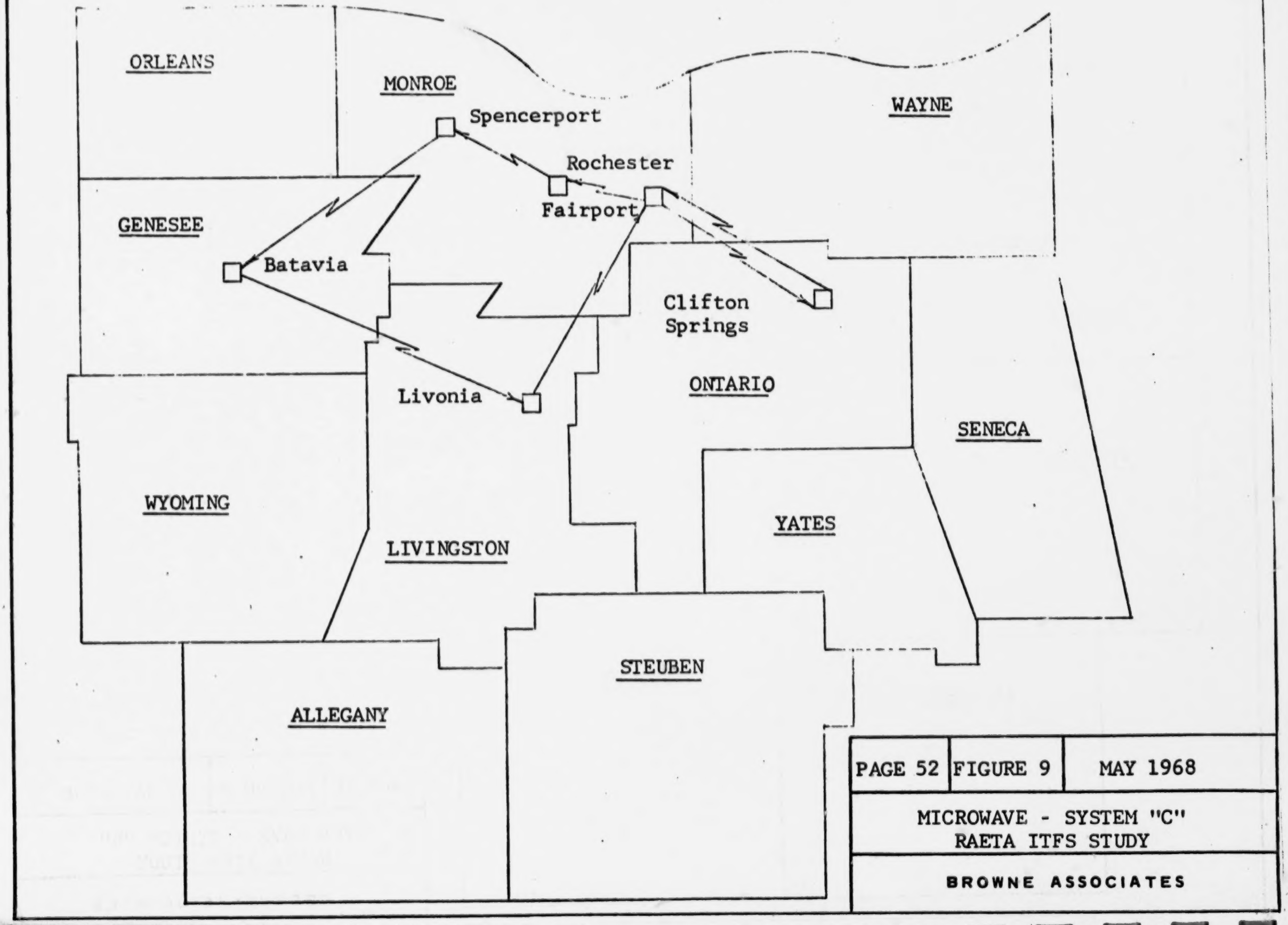
PAGE 50	FIGURE 7	MAY 1968

MICROWAVE - SYSTEM "A"
RAETA ITFS STUDY

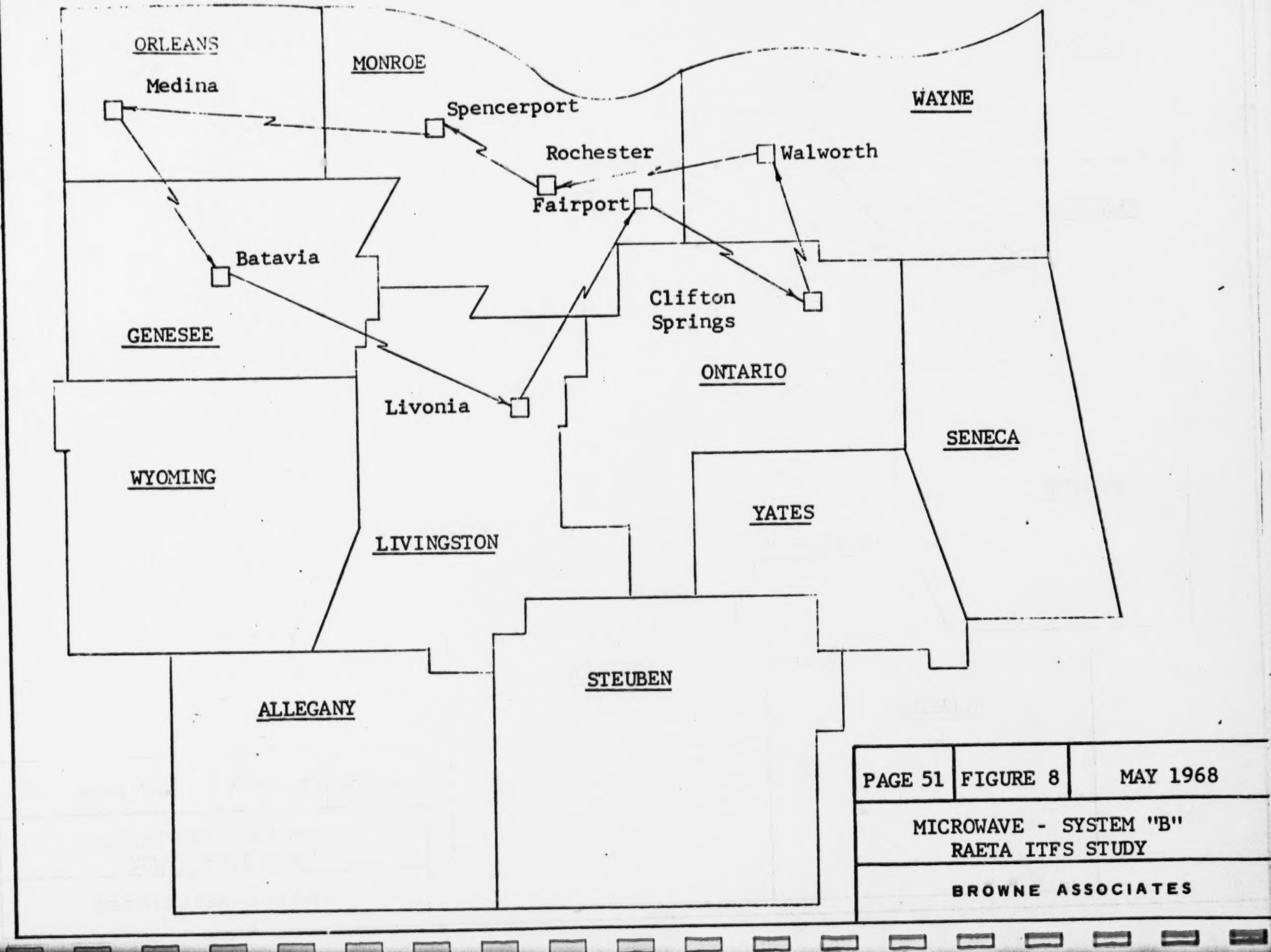
BROWNE ASSOCIATES



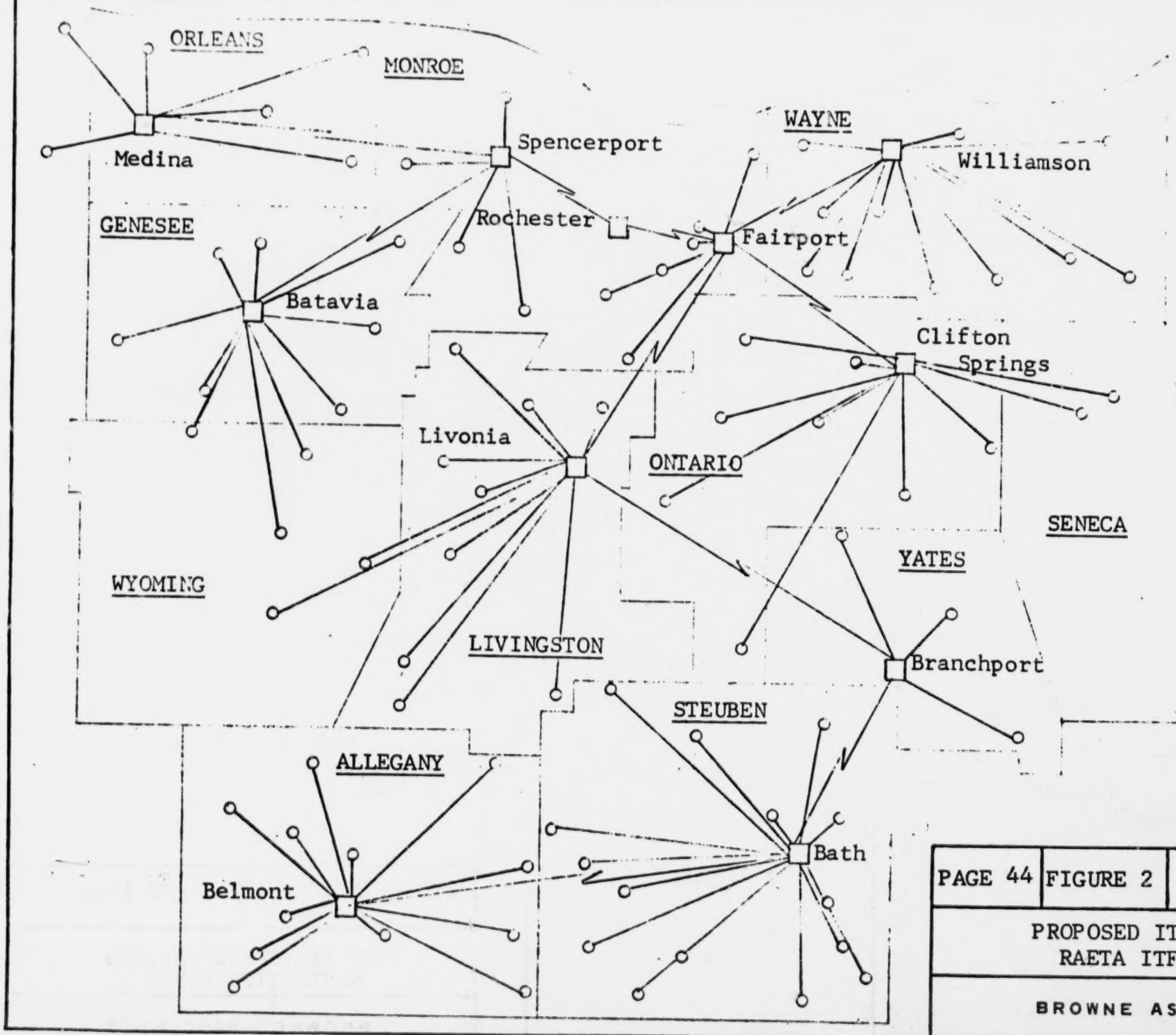
PAGE 49	FIGURE 6A	MAY 1968
ORANGEVILLE CENTER REPEATER RAETA ITFS STUDY		
BROWNE ASSOCIATES		



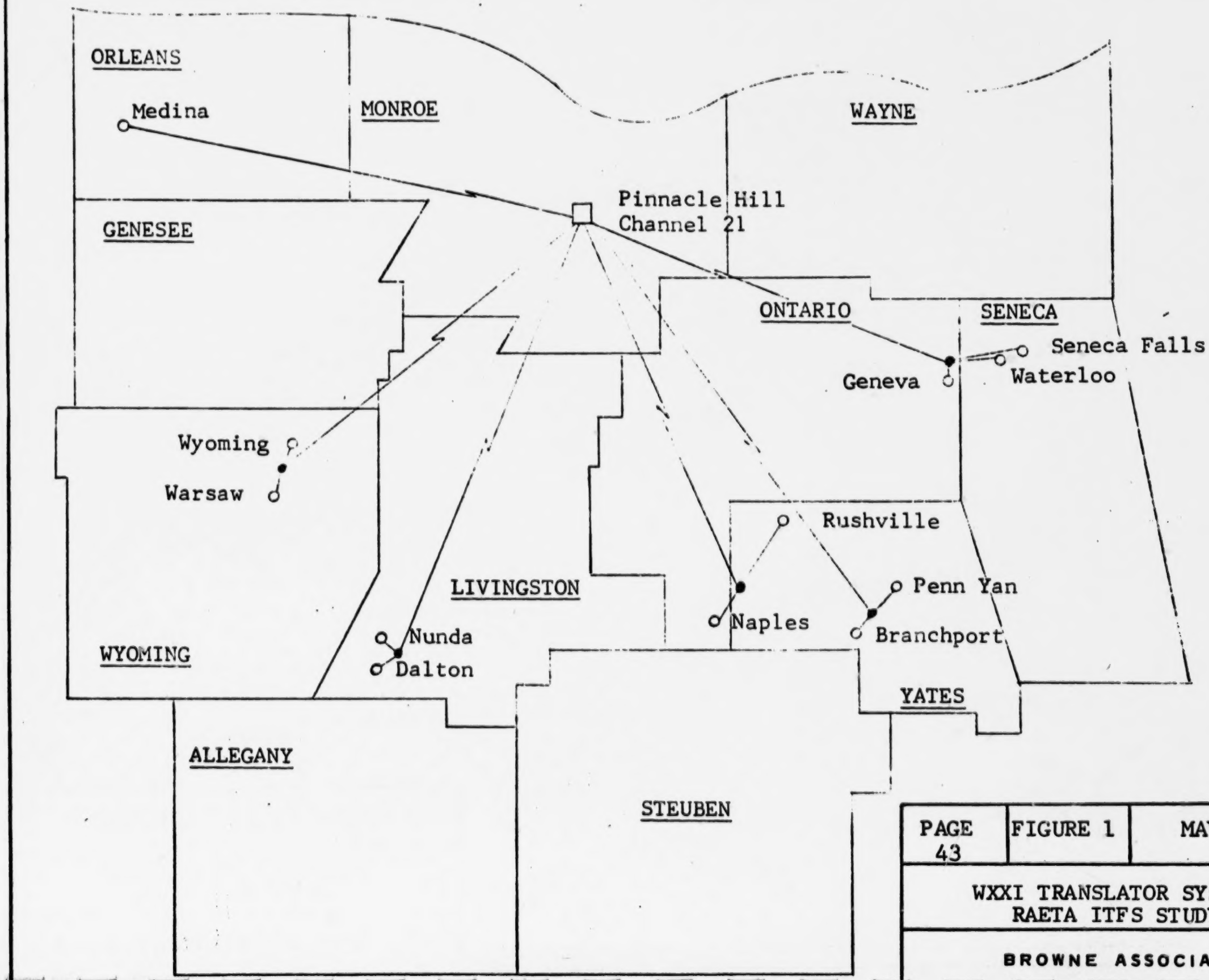
PAGE 52	FIGURE 9	MAY 1968
MICROWAVE - SYSTEM "C" RAETA ITFS STUDY		
BROWNE ASSOCIATES		



PAGE 51	FIGURE 8	MAY 1968
MICROWAVE - SYSTEM "B" RAETA ITFS STUDY		
BROWNE ASSOCIATES		



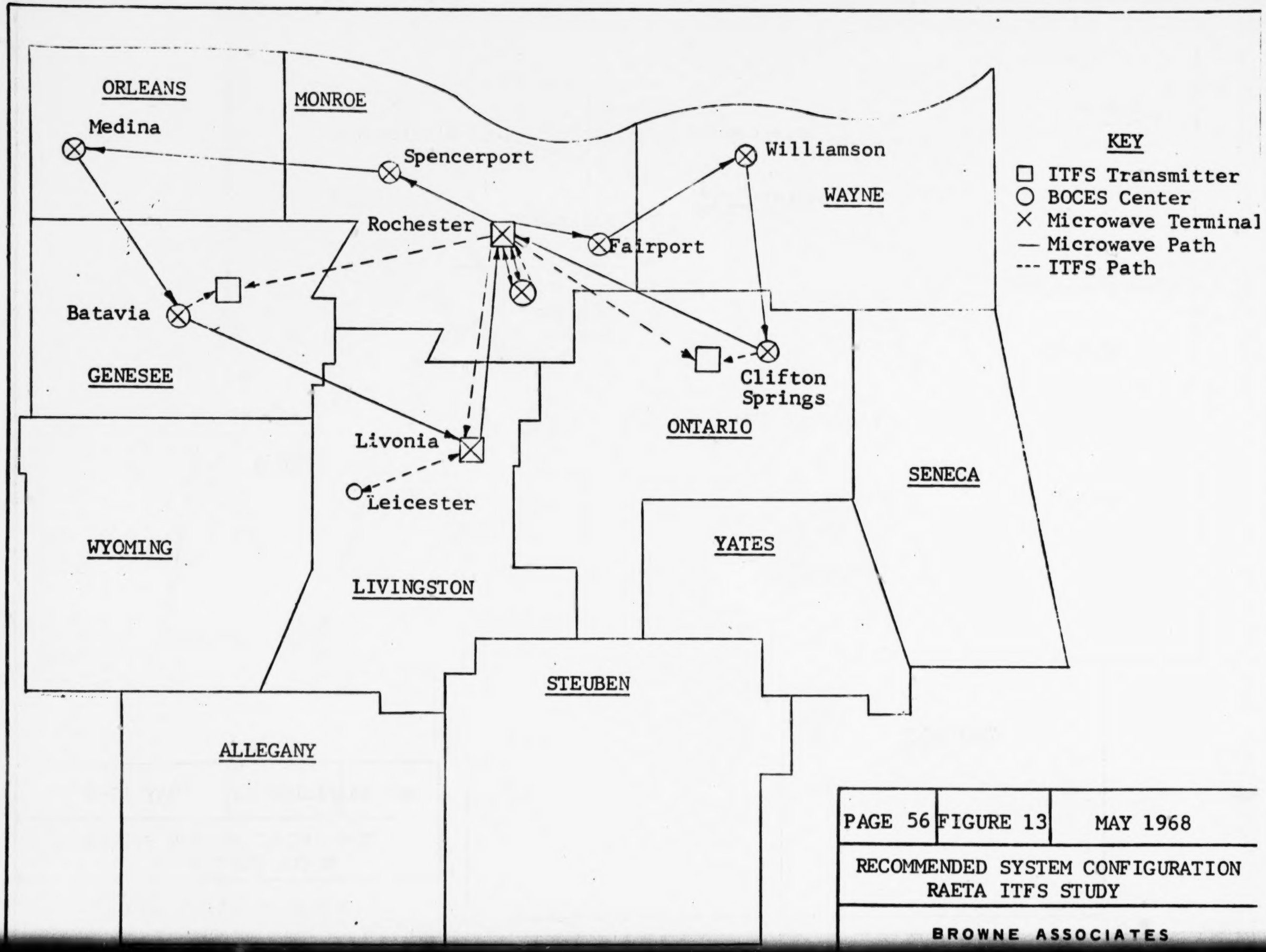
PAGE 44	FIGURE 2	MAY 1968
PROPOSED ITFS SYSTEM RAETA ITFS STUDY		
BROWNE ASSOCIATES		



PAGE 43	FIGURE 1	MAY 1968

WXXI TRANSLATOR SYSTEM
RAETA ITFS STUDY

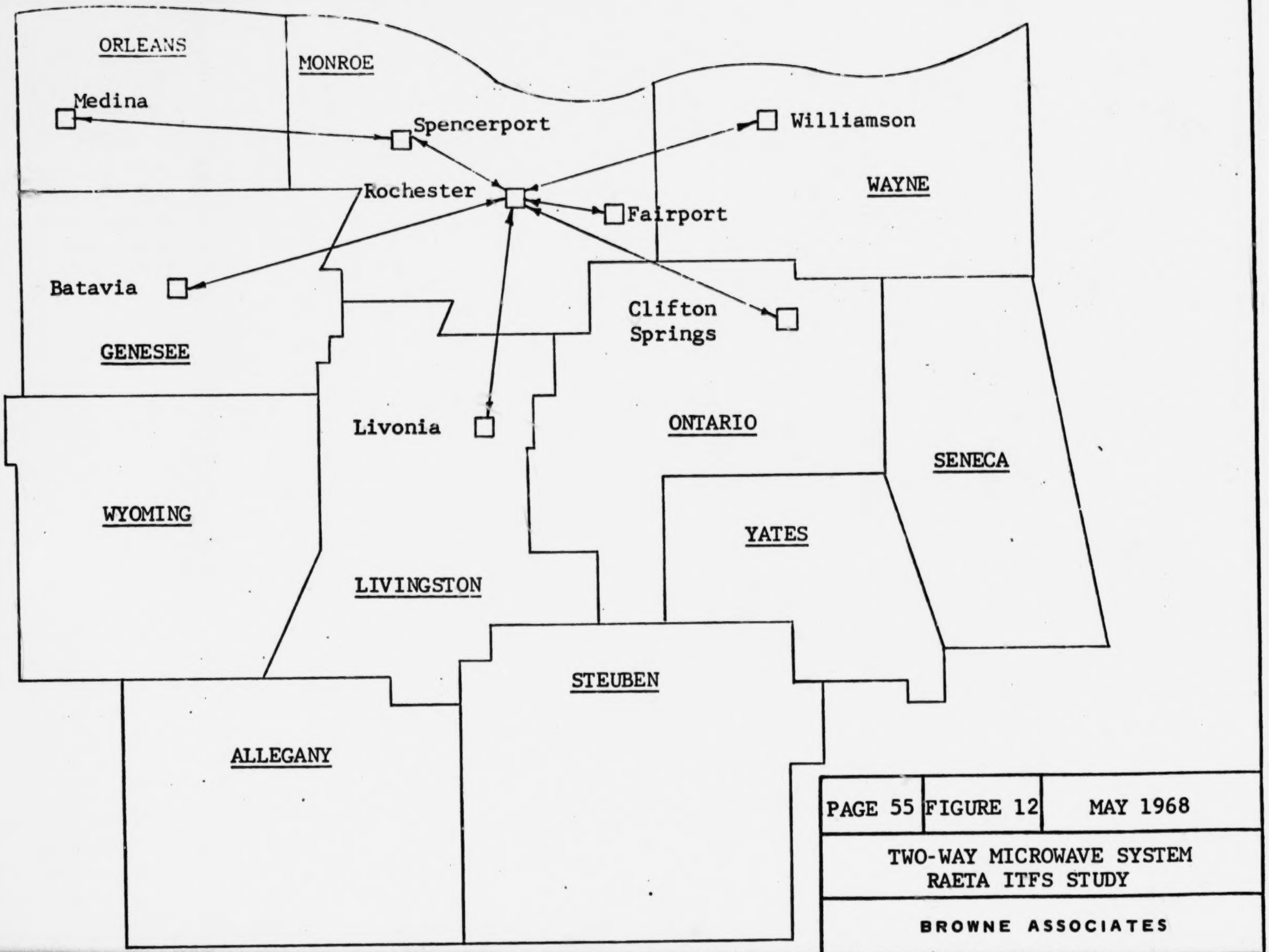
BROWNE ASSOCIATES



PAGE 56	FIGURE 13	MAY 1968

RECOMMENDED SYSTEM CONFIGURATION
RAETA ITFS STUDY

BROWNE ASSOCIATES



PAGE 55	FIGURE 12	MAY 1968
TWO-WAY MICROWAVE SYSTEM RAETA ITFS STUDY		
BROWNE ASSOCIATES		

ORLEANS COUNTY:	SITE NUMBER
Medina	1
Albion	2
Barker	3
Gasport	4
Holley	5
Kendall	6
Lyndonville	7

GENESEE COUNTY:	
Batavia	1
Alexander	2
Bergen	3
Corfu	4
Elba	5
LeRoy	6
Oakfield	7
Pavilion	8

LIVINGSTON COUNTY:	
Livonia	1
Avon	2
Caledonia	3
Dalton	4
Dansville	5
Geneseo	6
Lima	7
Mt. Morris	8
Nunda	9
Restof	10

ONTARIO COUNTY:	
Clifton Springs	1
Canandaigua	2
East Bloomfield	3
Geneva	4
Gorham	5
Honeoye	6
Naples	7

ONTARIO COUNTY: (Continued)	SITE NUMBER
Shortsville	8
Victor	9

WYOMING COUNTY:	
Attica	1
Gainesville	2
Perry	3
Warsaw	4
Wyoming	5

WAYNE COUNTY:	
Williamson	1
Clyde	2
Lyons	3
Madedon	4
Marion	5
Newark	6
Ontario Center	7
Palmyra	8
Savannah	9
Sodus	10
Walworth	11
Wolcott	12

MONROE COUNTY (WEST)	
Spencerport	1
Brockport	2
Churchville	3
Hilton	4
Scottsville	5

MONROE COUNTY (EAST)	
Fairport	1
East Rochester	2
Henrietta	3
Honeoye Falls	4

RECEIVING SITE LOCATION KEY

For Figure 14

Number Page 58

Page 1 of 2

Date May 1968

ORLEANS

MONROE

WAYNE

GENESEE

ONTARIO

SENECA

WYOMING

YATES

LIVINGSTON

ALLEGANY

STEUBEN

PAGE 57	FIGURE 14	MAY 1968

RECEIVING SITE LOCATION KEY
RAETA ITFS STUDY

BROWNE ASSOCIATES

MONROE COUNTY (E.) (Continued)	SITE NUMBER
Penfield	5
Pittsford	6
Webster	7
YATES COUNTY:	
Branchport	1
Dundee	2
Penn Yan	3
Rushville	4
SENECA COUNTY:	
Seneca Falls	1
Waterloo	2
ALLEGANY COUNTY:	
Belmont	1
Almond	2
Andover	3
Angelica	4
Belfast	5
Bolivar	6
Canaseraga	7
Fillmore	8
Friendship	9
Richburg	10
Rushford	11
Scio	12
Wellsville	13
Whitesville	14
STEUBEN COUNTY:	
Bath	1
Sand Hill	2
Addison	3
Arkport	4
Avoca	5
Campbell	6

STEUBEN COUNTY: (Continued)	SITE NUMBER
Canisteo	7
Cohocton	8
Corning	9
Greenwood	10
Hammondsport	11
Hornell	12
Jasper	13
Prattsburg	14
Savona	15
Troupsburg	16
Wayland	17

RECEIVING SITE LOCATION KEY

For Figure 14

Number Page 59

Date May 1968